Howrey Docket No.: 02578.0006.00US00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Scott A. Chalmers, et al.

Application No.: 09/611,219

Filed: July 6, 2000

For: **METHOD AND APPARATUS FOR HIGH-SPEED THICKNESS MAPPING OF PATTERNED THIN FILMS**

Art Unit: 2877

Examiner: Hoa Q. Pham

DECLARATION OF CHARLES HANNES PURSUANT TO 37 C.F.R. §1.132

I, Charles Hannes, hereby declare:

1. I am over the age of eighteen (18) years. The matters stated herein are either based on personal knowledge or are based on information and belief. If called upon to do so, I could and would testify as a witness to these matters.

2. All statements made herein on the basis of personal knowledge are true, and all statements made herein on the basis of information and belief are believed to be true.

3. I have no affiliation with Filmetrics, Inc., which I understand is the owner by assignment of the subject patent application.

4. I have almost thirty (30) years of experience in the field of semiconductor processing and inspection, and have particular expertise in the areas of semiconductor wafer processing and automation of semiconductor wafer processing.

5. From 1973 until the present, I worked for a variety of companies in this field including Cobilt Computer Vision, Macronetics, Applied Process Technology, Optical Specialties, Pacific Semiconductor, Applied Materials, Integrity One, IPEC, Allied Signal, Vecco, and Wilshire Technologies, Inc. In my work for these companies, I have been primarily involved as a Project Manager overseeing the design, development and integration of custom semiconductor processing equipment, including lithography inspection equipment, line width measurement equipment, defect detection equipment, and wire bonding equipment.

6. As Project Manager, my duties included interfacing with customers to understand their needs, evaluating and selecting equipment from various vendors for use in custom systems, and integrating the components of various vendors together to produce custom semiconductor processing equipment tailored to specific customer needs. Some of the vendors I have worked with include KLA-Tencor, IPEC, and Applied Materials. Together, these companies represent the largest manufacturers of semiconductor wafer inspection equipment, or chemical mechanical polishing (CMP) equipment in the world. Some of the customers I worked with include Intel and IBM. These companies represent some of the largest semiconductor manufacturing companies in the world.

7. I understand that the subject patent application is directed to a system for scanning an area on the surface of a wafer and capturing, through a special spectroscopic imager which is employed by the system, multiple one-spatial-dimension/one-spectral-dimension images representing the area on the surface of the wafer. The one-spatial-dimension/one-spectral-dimension images can be analyzed for various purposes, such as detecting the presence of an unwanted metal such as copper, or measuring the thickness of the wafer at several predetermined locations. As I understand it, the system is configured such that a typical 8 inch semiconductor wafer can be scanned and analyzed at a resolution of 100 microns or less, at a speed of 5 seconds or less per wafer.

8. I further understand that the Examiner of the subject patent application has asserted that, as of July 6, 2000, the filing date of the application, it would have been obvious to one of ordinary skill in the field of semiconductor processing to employ an ImSpector imager in a conventional semiconductor processing system employing an X-Y stage and a single spot scanner (represented by Kokubo, U.S. Patent No. 5,686,993) to achieve the system to which the subject patent application is directed.

9. I believe that this assertion is in error since, based on a data sheet for the ImSpector imager, which I understand was in effect as of the filing date of the application, the ImSpector suffers from one or more performance limitations which would have made it impractical to employ for the purpose of semiconductor processing. Consequently, I do not believe it would have been obvious to employ the ImSpector in the Kokubo system.

10. More specifically, in the field of semiconductor processing, as of July 6, 2000, it would have been necessary to scan at a resolution of 50 microns or less in order to capture sufficient detail about the semiconductor wafer. That is because 50 micron squares placed randomly on the wafer are required to guarantee measurement of 100 micron features. Moreover, it would have been necessary to scan a typical 8 inch wafer in about 10 seconds or less in order to allow integrated circuit manufacturers to measure every wafer without reducing manufacturing throughput significantly. Still further, the component cost of making such an imager should not have exceeded about $20,000 to have remained competitive from a price standpoint.

11. Yet, to scan a full line of an 8 inch wafer at the desired resolution of 50 micron or less with the ImSpector requires that 31 of such devices be placed side-by-side. That is because a full line of an 8 inch wafer represents about 4,000 picture elements (pixels) at a resolution of 50 micron , while a single ImSpector can only capture about 130 pixels in such a line. Thus, about 31 ImSpectors would have to have been placed side-by-side to have simultaneously captured a line extending across the full width of an 8 inch wafer. This would not only have been unduly complex to implement, but it would have been prohibitively expensive. In this regard, I understand that an arrangement of 31 ImSpectors would have cost about $125,000. This number far exceeds the acceptable budget (about $20,000) for this component of the system.

12. Moreover, even assuming this side-by-side arrangement could have been implemented, it would still have been too slow to have been competitive with other equipment that was then available. More specifically, assuming data captured by this arrangement could gave been clocked out at 60 frames/second, about 67 seconds would have been required to scan the entire area of the wafer. That is because the length of the wafer also represents about 4000 pixels, and 4000 pixels/60 frames/second is about 67 seconds. This far exceeds the 10 second per wafer figure which would have been needed to be practical.

13. In sum, because of these speed, cost and resolution related limitations, as of July 6, 2000, I do not believe one of ordinary skill in the field of semiconductor processing would have considered replacing the single spot imager in conventional semiconductor processing equipment with the ImSpector.

14. The reference in the ImSpector data sheet to "surface inspection" does not refer to semiconductor surface inspection. Instead, the reference is to web and surface inspection for "textile, interior material and graphics are production." These are all low resolution and low speed applications which rely on relatively low-level analysis (such as measuring the color of fabric). This is fundamentally different from a high resolution and high throughput application such as semiconductor thin-film analysis, which consists of much more complex and quantitative data processing.

15. Since the later 1970s, when integrated semiconductor chips began to be widely used in consumer electronic devices, there has been a demand by semiconductor manufacturers to increase the throughput of semiconductor processing equipment. The reason is that the cost of manufacturing semiconductor chips is directly related to the equipment. The higher the throughput, the lower the cost of manufacturing, and the lower the throughput, the higher the cost of manufacturing.

16. The demand for increased throughput became particularly acute in the early 1990s due to the escalating cost of semiconductor processing equipment and the smaller minimum device geometries (1 micron) that were then possible. Smaller device geometries entail greater chip densities, more layers per chip, and hence longer manufacturing times. Higher throughput processing equipment produces a greater volume of semiconductor chips in a given amount of time. Semiconductor chip manufacturers demanded the higher throughput equipment since the greater volume of production could be used to offset the higher equipment cost and the longer manufacturing times that were being experienced.

17. Throughout the 1990s, the demand for higher throughput equipment increased as device geometries decreased and the manufacturing times increased. In 1994, for example, minimum device geometries had decreased to .8 micron. By 1998, the figure had decreased to .35 micron. Presently, companies such as Intel are manufacturing devices with geometries as low as .09 micron. Throughput this time period, the throughput of semiconductor processing equipment steadily increased from 30 wafers per hour to up to 360 wafers per hour, which translates into a processing time of 10 seconds per wafer.

18. To meet the demand for increased throughput, manufacturers and developers of thin-film measurement equipment that is used in semiconductor processing have, to my knowledge,

focused principally on increasing the speed of conventional technology in which a single spot is successively scanned over the surface of the wafer, such as be using faster mirrors and X-Y stages to increase the speed at which the spot travels across the surface of the wafer. However, to my knowledge, until the present application, no one had thought to meet the increasing demand for throughput by employing a one-spatial-dimension/one-spectral-dimension spectroscopic imager in the field of semiconductor processing. Yet, such a device allows for a fundamental increase in throughput because it allows successive one-dimensional images to be captured from the surface of the wafer instead of just spots. Thus, the surface of the wafer can be traversed much more rapidly than with a single spot scanner. To me, the fact that no one, until the filing of the subject application, had thought to use these imagers in the field of semiconductor processing, despite the strong demand for increased throughput, is strong evidence of the non-obviousness of employing such devices in the field of semiconductor processing.

19. As an example, consider that, in the 1990s, work was underway at Hughes Aircraft Company to develop systems for measuring the thickness of thin-films on semiconductor wafers. Such work is represented by Ledger, U.S. Patent No. 5,291,269 (the '269 patent), a copy of which is attached hereto as Exhibit A. Yet, at about the same time, work was also underway at an affiliate of Hughes, known as Hughes Danbury Optical Systems, Inc., to use an imaging sensor, analogous to the ImSpector and known as a "pushbroom" imaging sensor, for airborne measurements of the earth's surface. Such work is represented by R. W. Basedow, "Hydice: Operational System Status," NASA, ISSSR-95, a copy of which is attached hereto as Exhibit B. Even though both efforts were underway within affiliates of Hughes, no one thought to apply the pushbroom imaging sensor to semiconductor processing. In fact, I personally worked with Anthony Ledger, the named inventor of the '269 patent, in this time frame at the Hughes Danbury facility in an effort to develop and design high throughput thin-film measurement equipment. We were both employed at the time by IPEC, which had purchased the portion of the Hughes Danbury facility involved with the development of thin-film measurement equipment. Neither one of us, or anyone else on the development team, had thought to apply the pushbroom imaging sensor to the area of thin-film measurement.

20. I am aware that willful false statements and the like are punishable by fine or imprisonment or both (18 U.S.C. 1001), and may jeopardize the validity of this patent application, or any patent issuing thereon.

Executed on this 6 day of December, 2002 at Carlsbad, California.

Charles Hannes